

II.—LIST OF MAPS NOT DIRECTLY USED IN COMPILATION OF NEW MAP OF PERSIA, BECAUSE EITHER SUPERSEDED OR ALREADY EMBODIED IN MAPS MENTIONED IN CLASS I.; BUT USEFUL FOR PURPOSES OF REFERENCE.

PERSIA.

Title of Map.	Author.	No. of Sheets.	Scale of Miles. to Inch.	Place and Date of Publication.
Boundary between Persia and Turkey.	H. A. Churchill	1	24	London, 1855.
N.E. Persia	N. Khanikoff (1858-9) .	1	48	Paris.
Persian Gulf, &c.	Rev. G. P. Badger	1	33	London, 1871.
Route, Sistan to Moshed	Gen. F. J. Goldsmid .. .	1	8	Calcutta, 1872.
Persia	Major O. B. St. John .. .	6	16	London, 1875.
Journeys through Persia	Col. C. MacGregor .. .	1	16	Calcutta, 1875.
Khuzistan	Intell. Div. War Office	1	4	London, 1875.
N.E. Persia and Herat Valley.	Major O. B. St. John .. .	1	12	Calcutta, 1878.
Persia, Afghanistan, Beluchistan.	H. Kiepert	1	41½	Berlin, 1878.
Russisch-Persischen Grenze	(‘Petermann’s Mitteil.’)	1	13½	Gotha, 1884.
Topographie von Persien	Von Tomaschek	1	15½	Vienna, 1885.
Persia and Afghanistan..	Keith Johnston	1	68	Edinburgh, 1889.
Persia, Afghanistan, and Beluchistan.	(Philips’ Travelling Maps)	1	62	London, 1891.
Iran und Turan	(Stieler’s Atlas)	1	118	Gotha, 1891.

Why are the Prairies Treeless?

By MILLER CHRISTY, F.R.S.*

ALL who are familiar with the Prairies of the West must, I think, have asked themselves at times the question which stands at the head of this paper:—Why are the Prairies treeless? That treelessness is an essential characteristic of prairies, of course does not need stating; but the fact does not carry with it any explanation of itself.

In America, at least, as one writer has observed,† “there has been no lack of literature on the subject of the prairies of the Western States and Territories, nor any dearth of theories to account for their origin. We have had their existence ascribed to fire and to water; to heat and to cold; to all sorts of phenomena and to the lack of them. It has been held that the forests that once clothed these regions must have been burned up by prairie fires — before the prairies existed; that they must have been drowned out by the waters of vast inland lakes that once covered these prairie states; that they must have been parched up by the dryness of the climate; that they must have been smothered.

* An abstract of this paper was read at the Geographical Section of the British Association, Cardiff Meeting, last August.

† ‘American Naturalist,’ vol. xii. (1878) p. 299.

by the impalpable fineness of the soil in which they grow; that they never had any existence; and that the seeds which ought to have produced them must have been ground to pumice by the glaciers of the age of ice, or hopelessly buried beneath their *débris*."

So hotly, indeed, has the origin and treelessness of the prairies been debated in America, that the above statement, though humorous, is not exaggerated. Naturally, however, the subject has received far less attention on this side of the Atlantic, and there is no work published in this country which fully presents all the aspects of the question.

It is first necessary to make two explanations. In speaking of prairies, I refer to the *true* prairies only, and not to the arid, sterile region now commonly spoken of as the Great Plains, but formerly called the Great American Desert. It is very common for people to confound the *Prairies* of North America with the *Plains*; but this should on no account be done; for the prairie-region has features and characteristics quite different from those of the plain-region.

The true prairies may be said to be confined to the valley of the Mississippi; for, although the prairie-region extends to the northwards, beyond the international boundary-line, far into Canada, where it occupies a large part of the valleys of the Red River and the Saskatchewan, the valley of the former river at least may (for present purposes) be regarded as a continuation northward of the valley of the Mississippi, though with a different slope.

Broadly speaking, the prairie region of North America covers the southern portions of Michigan and Wisconsin; the western portions of Ohio, Kentucky, and Tennessee; the eastern portions of Texas; the Indian territory, Kansas, and Nebraska; the whole of Indiana, Illinois, Arkansas, Missouri, and Iowa; the eastern halves of the State of Minnesota and the Canadian Province of Manitoba; Dakota as far west as the Missouri river; and all the North-West Territories of Canada, south of the Saskatchewan river, as far west as the 104th degree of west longitude. On the north, the prairie region passes into the great sub-arctic pine forest; on the east, into the light deciduous forests and cultivated lands of the eastern States; on the south, into the low marshes around the mouth of the Mississippi river; and, on the west, it everywhere passes more or less abruptly into the higher and more arid region of the Plains.

In the region of the Upper Mississippi and the Red River, the true prairies may be said to occupy the first and second of what are usually known in that region as the "Three Prairie Steppes."

The most striking features of the true-Prairies are, of course, their treelessness, in spite of their excessive fertility, their level surface, their abundant growth of grasses, and the fact of their being (taken as a whole) well-watered.

The true Plains, on the other hand, are remarkable for their very

slight rainfall, their light sterile soil, their scant covering of grass, and their greater elevation. Roughly speaking, the true plains occupy all the country between the prairies and the Rocky Mountains, and even beyond "where [as Prof. Hind says] both soil and climate unite in establishing a sterile region."

What I shall hereafter say as to the cause of the treelessness of the prairies does not apply also to the plains, which are probably treeless through different causes altogether.

I am able to claim more or less personal acquaintance with by far the greater portion of the prairie area. The only part I have never visited is the south. With the northern portion I am fairly well acquainted, especially with Minnesota, Dakota, Manitoba, and the Northwest Territories of Canada, to all of which I have paid many visits. I state this merely to show that I am not treating theoretically of a subject of which I have no personal knowledge. Further, I think I may claim that that part of the prairie region with which I am most familiar is the only part in which the cause to which I attribute the treelessness of the prairies may be now properly observed, the long settlement of the more southern portion having altogether removed and obliterated that cause.

One further explanation is needed here: In speaking of the treelessness of the prairies, I of course do not forget that, even in many truly prairie areas, the swampy parts and islands in lakes are often timbered, while belts of trees fringe most of the streams, and groves of trees often appear upon the open prairie. In Manitoba, these groves are known as "bluffs," by which name I shall often have occasion to speak of them. The existence of these trees, however, in no way affects my main contention.

We now come to the consideration of the question—Why are the prairies treeless? But, before stating my own view, it will be well to explain and discuss the principal of the many views on the subject which have been expressed by others.

Perhaps the most reasonable of these views is that of Prof. Leo Lesquèreux, who takes the view,* that prairies have all been lake-beds. "This peculiarity of formation," he says, "explains first the peculiar nature of the soil of the prairies. It is neither peat nor humus, but a black soft mould, impregnated with a large proportion of ulmic acid, produced by the slow decomposition (mostly under water) of aquatic plants, and thus partaking as much of the nature of peat as of that of the true humus. . . . It is easy to understand why trees cannot grow on such kind of ground. The germination of seeds of arborescent plants needs free access of oxygen for its development; and the trees, especially in their youth, absorb by their roots a great amount of air, and demand a solid point of attachment to fix themselves. . . . Considering the

* 'Geological Survey of Illinois,' vol. i. (1886) p. 240.

whole explanation of the formation of the prairies, as it is exposed in this paper, I think that it covers the whole ground and applies to most of the cases (if not to all) where the ground is naturally naked, or without trees."

Another ingenious theory is that of Professor J. D. Whitney, of the Geological Survey of Iowa.* After expressing his opinion that the theory I shall hereafter support is entirely untenable, and after bringing forward evidence showing the unsoundness of the view, advanced by some, "that the want of sufficient moisture in the air or soil was the cause of the absence of forests in the North-west," the Professor proceeds as follows:—

"Taking into consideration all the circumstances under which the peculiar vegetation of the prairie occurs, we are disposed to consider the nature of the soil as the prime cause of the absence of forests. . . . And, although chemical composition may not be without influence, . . . yet we conceive that the extreme fineness of the particles of which the prairie soil is composed is probably the principal reason why it is better adapted to the growth of its peculiar vegetation than to the development of forests. . . . The soil and superficial material have been so finely comminuted as to be almost in the state of impalpable powder. If we go to a thickly-wooded region, . . . we shall observe that the beds of ancient lakes . . . remain as natural prairies and are not trespassed upon by the surrounding woods. We can conceive of no other reason for this than the extreme fineness of the soil which occupies these basins. . . . Applying these facts, . . . we infer (on what seem to be reasonable grounds) that the whole region now occupied by the prairies of the North-west was once an immense lake, in whose basin sediment of almost impalpable fineness was gradually accumulated. . . . On the prairie, we meet sometimes with ridges of coarse material, apparently deposits of drift, on which (for some local cause) there has never been an accumulation of fine sediment; in such localities we invariably find a growth of timber. This is the origin of the groves scattered over the prairies."

Prof. Alexander Winchell, of the University of Michigan, has promulgated a curious theory which may be summed up in his own words:†—

"We may discover the origin of the prairies in the last great geological revolution of the globe. . . . There are two facts to be accounted for: 1st, the physical peculiarities of the soil and subsoil of the prairies; and 2nd, the absence of trees from those areas, in cases where no obvious cause exists. (1) The soil of the prairies is a lacustrine formation; (2) lacustrine sediments enclose but few living

* 'Report on the Geological Survey of Iowa,' vol. i. (1858) p. 24.

† "On the Origin of the Prairies of the Valley of the Mississippi," in the 'American Journal of Science and Arts,' second series, vol. xxxviii. (1864) pp. 322-324.

germs; (3) diluvial deposits, on the contrary, are found everywhere replete with living germs; (4) the living germs of the diluvial deposits were buried during the glacial epoch; (5) in proportion as the diluvial surface became exposed, the flora of the pre-glacial epoch was reproduced; (6) the vegetation which finally appeared on the drained lacustrine areas was extra-limited, and was more likely to be herbaceous than arboreal."

The number of other theories that have been advanced at different times to account for the treelessness of the prairies is very great; but these theories are, for the most part, more or less improbable. They all leave us face to face with the paradox that in spite of an abnormally fertile soil, a fairly heavy rainfall, a moderate elevation, and a favourable climate and geographical situation generally, vast (and, perhaps, increasing) areas remain permanently treeless, although they produce a rich variety of grasses and other small herbaceous plants.

To the solution of this point, then, let us now turn our attention. My unhesitating belief is that the treelessness of the prairies is due mainly to artificial causes; that the agency by which the prairies have been brought to their present state is chiefly FIRE—one of the best servants and worst masters man ever had.

To the prevalence of prairie fires in the past, I attribute, to a large extent at least, the very existence of the prairies themselves; their dreary treelessness; the extraordinary fertility of their soil, and its fine, black, soot-like texture; the alteration of the flora; and the extermination of certain organic creatures (which are usually abundant in similar situations, and would, I believe, exist now on the prairies had it not been for the fires). The idea that the treelessness of the prairies is due largely to the action of fire is not by any means new. It crops up continually, as an almost accepted fact, in the accounts of travel in the prairie region which the more observant travellers have given us.

Every one is familiar with the stirring tales of the huge fires which occur on the prairies, and of the way in which hunters and travellers are accustomed to "fight fire with fire," when placed in situations of danger. But not a few persons in this country have, I believe, a vague sort of idea that these fires are in some way due to natural agencies; but all the evidence goes to show that they are due to human agency, and there is little or none to the contrary.

Prairie fires, in the first case, originated among the Indians, who, when on their "great fall hunts," used to "put out fire" as a signal to their friends that they had found buffalo, or with the object of more effectually gathering the animals together, by limiting their feeding-ground. Lieut. R. I. Dodge* says, "The Indians burn portions of the prairie (i. e. "the plains" of America) every fall, setting the fire so as to burn as vast an extent of country as possible, and yet preserve

* 'Hunting Grounds of the Wild West,' p. 29.

unburnt a good section in the vicinity where they purpose to make their fall hunt. The buffaloes, finding nothing to eat on the burned ground, collect on that unburnt, greatly reducing the labour of the hunt."

In the present day, however, fires have probably a different origin from those of years past. They are caused in nearly every case by travellers who carelessly neglect to extinguish their camp fires; by persons who maliciously put out fire; or by settlers who do so for the purpose of improving the pasturage the following year, or with the mistaken idea that by burning the grass they lessen the number of mosquitoes.

Fires take place in the spring and autumn. When the buffalo existed, prairie fires mainly took place in the *autumn*, before the winter snows had fallen; but the majority (or, at least, many more than formerly) now come in the *spring*. The reason for this is, that the settlers do not like fire in the fall, because they prefer to keep the pasturage for their cattle until as late a period in the year as possible, and also because there are at that season stacks of corn and hay standing about in every direction; but, in the spring-time, none of these reasons has any force, and the settlers then burn the prairie, as soon as the disappearance of the snow has left the dead grass dry enough to "carry fire."

Towards the end of September, the prairie, which up to that time has been gay with a never-failing succession of brilliant flowers, becomes of a uniform, sombre brown colour. A very abundant, bright blue species of gentian is the last flower to appear; when that is over, nothing remains but a few stray blossoms belonging to an odd assortment of species; while, with the first sharp frosts of autumn, the grass (hitherto green) becomes dead, dry, and highly inflammable. From this time until the first fall of snow (which often does not come till December) is the period when the autumn fires appear; or, if they do not come then, the dead grass remains and can be burned as easily the following spring.

Before visiting the prairies, I had no clear idea as to the great prevalence of the fires, regarding them as occasional occurrences only; but, from what I have seen and heard, I imagine that by far the larger portion of the whole area of the prairies gets burned over annually. Dr. C. A. White, of the Geological Survey of Iowa, speaking of the grasses and other herbaceous plants which grow upon the prairies,* says: "These together cover the ground every season; for the fires of one year do not at all impair or prevent their abundant growth the next. Stringent laws are enacted in all the prairie States against the setting of fire to the prairies; yet each year's growth of grass, upon at least the larger ones, is somehow almost invariably burned." This is not surprising when it is considered that the only conditions required

* 'American Naturalist,' vol. v. (1871) p. 68.

for fire to run over hundreds of miles—or round the world, for the matter of that—are a more or less strong wind behind and a level stretch of dry grass in front. I myself saw a fire which I had reason to believe was 40 miles in length; while Professor H. Y. Hind says: * “From beyond the south branch of the Saskatchewan to the Red River, all the prairies were burned last autumn [1857]—a vast conflagration extending for 1000 miles in length and several hundred in breadth. The dry season had so withered the grass that the whole country of the Saskatchewan was in flames. The Rev. Henry Budd, a native missionary at the Nepowewin, on the north branch of the Saskatchewan, told me that, in whatever direction he turned in September last, the country seemed to be in a blaze. We traced the fire from the 49th parallel to the 53rd, and from the 98th to the 108th degree of longitude. It extended, no doubt, to the Rocky Mountains.”

It is certain, however, that the prairie fires now are not so extensive as formerly, although probably they are more numerous, on account of the very much greater number of persons there are to start them. That their courses should be shorter now than formerly is not due to any increase of the chief natural obstacle to their progress—namely, water, in lakes or streams—but to the amount of ploughed land which now, both in spring and autumn largely checks their movements; for, on stubble, fire can “run” before a very high wind only.

But, if I have been compelled to enlarge my ideas as to the ordinary frequency and extent of the fires, I have, on the other hand, found it necessary to contract my notions as to their average magnitude. It appears that everything depends on the length of the grass and the strength of the wind. Every settler with the slightest grain of forethought, provides his house and premises with what is known as a “fire-guard.” This is done by the very simple process of turning a few furrows with a plough all round his premises. Many a settler, through the neglect of this precaution, or when he has allowed his fire-guard to become old and overgrown with grass, has suffered the loss of a stack of wheat, oats, or hay, his farm-buildings, or a comfortable house or shanty, built with the labour of his own hands. Not a few persons, whose ideas of prairie fires have been gathered from what they have read, or from pictures in which men, horses, cattle, buffaloes, hares, deer, birds, and what not, are depicted as flying before the flames, may feel disinclined to believe that such a simple precaution could be sufficient to stay the onward progress of a fire; but in most cases it suffices.

On the drier portions of the prairies, the grass is short and scanty, and a fire will not “run” unless there be considerable wind to drive it. Even then it is but a very small affair—merely a narrow flickering line of advancing flame, which might almost be flicked out with a pocket-

* ‘Narrative of the Canadian Red River, Assiniboine, and Saskatchewan Exploring Expeditions of 1857 and 1858,’ vol. i. p. 292.

handkerchief; and indeed, as a matter of fact, is often brushed out for short distances with a wet sack or broom by settlers anxious to preserve their homes; for, if the fire be stopped along the windward side of a settler's premises, the wind carries the two wings of the fire on past the sides of the buildings; and, although they may eventually join again to the leeward, they cannot then return to burn the premises, unless the wind shifts completely round.

Such small fires as those of which I now speak are often stopped for considerable distances by obstacles of much smaller importance than a settler's fire-guard; for instance, by the numerous "trails," as the prairie roads are called in Canada. These, though merely two narrow wheel-marks with an ox-path in the centre and grass growing between, often stop fires for short distances; but, being able to cross the trail at other spots, the broken line of flame gradually joins again, leaving many triangular patches of unburnt grass on the leeward side of the trail, the apex of the triangle of course pointing in the direction in which the fire has gone.

I saw instances of this one bright moonlight night, when I was travelling over the dry, sandy prairie between Fort Ellis and Elkhorn. The short, scanty grass had been burned by a fire, the lurid glare of which I had plainly seen, miles away, after dark on the previous evening. The trail I travelled on, though but faintly worn, served, nevertheless, to check the fire for 100 yards in some places, so that on one hand I had burned and on the other unburned prairie; but in places the flames had contrived to creep across, and had gone on their way rejoicing. On one occasion, too, I remember seeing a spot where a small fire had been checked, for several yards at least, by the wheels of a waggon having previously crossed its track, pressing down the short grass, though they had left almost no impression on the soil. Such trumpery fires as these are the rule in dry districts; but there are times when the wind is strong, and the waving grass grows long and rank in a moist soil, when fires occur of much more serious proportions. Then a great wall of flame, yards in height, rushes along, causing danger to travellers and destruction to all kinds of settlers' effects. I have been credibly informed that such fires find no difficulty in leaping such a river as the Assiniboine.

The grass on the prairies becomes, in the autumn, much drier and more combustible than it usually does in Europe; and, when it is remembered that the American climate is much drier than ours, that high winds are more prevalent, and that the area over which a fire can run, when once started, is of enormous extent, no one need wonder that very great conflagrations often take place. Nor is it difficult to see why such fires do not gain ground in civilised countries, such as England. The grass here is greener and much more succulent; it is generally fed-off so close that there is little or no dry inflammable portion left;

unbroken grassy levels of great extent are rare; the climate is moister; high winds are not so frequent; while the number of hedges and the large extent of cultivated ground would soon check any fire that once got started. Still, some idea of a prairie-fire on a small scale may be gained by watching the burning grass in summer on English railway embankments.

The spectacle presented by a large prairie fire at night is one of the most terrific sights imaginable. The lurid red glare from flames hidden below the horizon overspreads the entire sky, and gives to everything a most unearthly appearance; while, by day, the vast volumes of smoke, rising and blending with the clouds, are almost equally awe-inspiring. I have seen many such fires on my various visits to the prairies. As Prof. Hind says: *—"The grandeur of the prairie on fire belongs to itself. It is like a volcano in full activity; you cannot imitate it, because it is impossible [elsewhere] to obtain these gigantic elements from which it derives its awful splendour."

Dr. C. A. White, of the Geological Survey of Iowa, has given us a graphic picture of the perils to which travellers on the prairies may be exposed from fire.† It is by a recognised man of science, and may therefore be relied upon more than the tales of uneducated settlers or imaginative novelists.

It being now understood how very prevalent these prairie fires are, the reader will, in a measure, be prepared for my statements as to the very powerful effect they have been able to exercise upon the face of the country in various ways.

First, let me take the matter of the blackness and fertility of the soil. That the soil is very black and very fertile has already been stated; and, with the knowledge already gained as to the prevalence of fires, it seems only like putting two and two together to make four, to conclude that these features are due to the fires. After a fire, the ash of the burnt grass is left as a black deposit upon the surface of the ground; and this is especially the case in the damp bottoms of "sleughs," and where the willows make the grass long and rank by shading the soil and keeping it moist. Such spots, at a little distance, appear, when burned, much blacker than the rest of the prairie, and examination shows the deposit of ash to be sometimes as much as one-eighth of an inch in thickness. Now it is a matter of common observation that the black prairie loam is usually blackest in such situations, and I do not think it is at all difficult for any well-trained mind, capable of weighing the effect of a very small cause very often repeated, readily to comprehend that the blackness, fineness, and fertility of the soil of the prairies is the effect, in a very large measure at least, of the annual deposition, for many generations past, of a very small quantity of this grass ash,

* 'Exploring-Expeditions,' vol. i. p. 336.

† 'American Naturalist,' vol. i. (1871) p. 69.

which must undoubtedly have great manurial value. In Minnesota and Manitoba, the thickness of the black loam varies from about one to three feet; but, taking the average at about eighteen inches, and the average annual deposition of ash at only one-thirty-second of an inch, we find that it would have taken just 576 years to deposit eighteen inches of soil by this means alone. But the ash would certainly rot further and become consolidated after deposition; therefore let us double our figures, and we get 1152 years as the time required for the formation of eighteen inches of black loam. Of course, in moist districts, where the grass grows long, the rate would be higher, and in dry districts lower. I am perfectly aware that the foregoing is a very vague, and largely a speculative, calculation, but it will serve to illustrate my point.

The belief as to the black loam having originated thus is far from original, as I met and conversed with many settlers and others on the prairies who fully supported it. If the blackness and fertility of the soil are not due to the fires, to what are these features due? I have heard it maintained that the gradual decay of the grass for generations past was the cause; but dead grass and leaves have decayed in many other places for generations without leaving, so far I have seen, a soil nearly so black as that of the prairies.* The opinion of Prof. Sheldon, of the Agricultural College, Downton, Wiltshire, is only another piece of evidence in favour of the fires, though he does not allude to them. He writes: "The soil of Manitoba is a purely vegetable loam, black as ink and full of organic matter, in some places many feet [?] thick resting on the alluvial drift of the Red and Assiniboine rivers."

The following analysis of the prairie soil is given on the authority of Prof. Baker Edwards, of Montreal:—

Moisture	4.6
Organic matter	11.8
Phosphate and carbonate of lime	31.4
Soluble alkaline salts, potash and soda	8.6
Insoluble silica and gravel	43.6
	100.0

Obviously the perpetual occurrence of prairie fires must have exercised a very powerful influence upon the flora and fauna of the prairie country. We will take the latter first.

It is a remarkable fact that, although many species of fresh-water mollusca inhabit almost every pond, lake, and stream on the prairies, not a *single* species (so far as I could discover) inhabits the bare open prairie in Manitoba, although I have given a good deal of attention to the molluscan fauna of that country during my various visits to it.†

* Prof. Arthur Winslow, State Geologist of Missouri, writes that he is in full accord with me as to the origin of the black soil. "I consider the fires," he says, "a cause of first importance."

† 'Journal of Conchology,' vol. iv. (1885) pp. 339-351.

That this is not due to the cold of winter, is, I think, obvious. I am convinced that the prairie fires must again be put forward as the cause of this remarkable fact; for I was careful to observe that the fire burns the grass so completely down to the ground that, had any molluscs been sheltering among its roots (as they habitually do in England), they would certainly have been burned. Not unfrequently, in dry parts of the prairie, the settlers cut hay round the ponds which collect in the depressions, afterwards setting light to the rushes to make the grass more succulent next year. In many such cases I noticed, where the pond had been dried up by drought, leaving the molluscs lying on the hard mud, that the flames, in burning the rushes, had burned and calcined the shells so thoroughly that their occupants would certainly have been killed had they not been already dead through the effect of drought. There are, however, a few small species of land-snails inhabiting the extensive spruce-swamps and the wet moss beside the "sleughs."

Further, there are, I believe, at the present time, very few species of mammal habitually frequenting the open prairie, *except burrowing ones*. An exception to this has to be made on account of one or more species of hare; but these in most parts of the prairie are rare, though common in the woods. In times past, of course, the buffalo and the antelope formed other exceptions. The prairie wolf, or coyote (*Canis latrans*) is essentially an inhabitant of the scrub, though it is often driven to seek its food on the open prairie in winter. These facts may, I believe, be most easily explained by supposing that the fires, by constantly sweeping over the prairies, have rendered them largely uninhabitable, except by burrowing animals.

To the same cause may, I believe, be attributed (at least in a large degree) a still more remarkable circumstance, namely, the entire absence of earthworms from the prairies of the North-west. I have been assured of this absence by many settlers, and have verified it by my own observation. Having elsewhere treated more fully of the subject,* I will but briefly refer to it here. Every one is acquainted with Darwin's interesting work, in which he shows that over the larger portion of the earth's surface we are in no slight measure benefited by the actions of these humble creatures. They are, in fact, nature's agriculturists, which, for generations past, have regularly ploughed and rendered the soil fertile in their own way. But, as there are no earthworms in the North-west, it is certain that the exceptional fineness and fertility of the soil of that country cannot be due to their action; consequently this enormous area of many million square miles must be regarded as forming an exception to the general rule shown to exist by Darwin. This absence of earthworms is rendered all the more noticeable by Darwin's remark that "earthworms are found in all

* Nature, Jan. 3, 1884, p. 213.

parts of the world, and some of the genera have an enormous range. They inhabit the most isolated islands," &c.; and, further, that "worms throw up plenty of castings in the United States."

I do not know of any cause which can satisfactorily account for the absence of worms from the prairies, except fire, which, by burning the grass over large areas, would annually deprive the worms of that variety of decaying vegetable matter which constitutes their food. Frost, the only other possible cause, seems inadmissible, since worms occur in Iceland, hundreds of miles to the north.

It appears, therefore, as if the cause which has deprived the soil of the prairies of that natural cultivation by means of worms, which the soils of most other countries enjoy, has, at the same time, liberally supplied it with a manure resulting from the ashes of the grass which is annually burned.

We come now to the consideration of my assertion:—That the fires, by gradually killing and consuming the forests, have caused the treelessness of the prairies; or, in other words, that the prairies themselves are, largely at least, due to fire. The evidence on this point is, I think, very clear. It can be shown, I think, on the clearest evidence, that, if the fires have not caused the prairies, they are at least now extending them in numberless places; that trees still grow on the prairies on spots that are to some extent protected from the fires; and that, over large portions of the prairies, young trees spring up annually, only to be at once burned; but, if protected from the fire, they would grow and in due time reproduce the banished forest-growth.

In considering these assertions, it is first necessary to show that there is nothing in the physical or chemical constitution of the soil of the prairies which prohibits the growth of trees; or, in other words, that trees, if introduced, will flourish in the prairie soil. Obviously, if it could be shown that trees were unable (from any cause, known or unknown) to exist in the soil of the prairies, and, therefore, that they had never existed there, it would be futile to contend (as I do) that the trees which formerly flourished have been destroyed by fire, while the same agency prevents others from replacing them.

I am not aware that any one seriously denies that trees may be readily grown upon the prairies, if planted and properly tended. It is true that in Minnesota, Dakota, Manitoba, and other newly-settled districts, many settlers have planted poplar, maple, or other trees round their houses as "wind-breaks," and generally with the very worst success. But, in a country where the winds are so strong, trees, if planted at all on the open prairie, need some protection at first, such as being planted in clumps, or, still better, raised from seed in plantations. That they will grow from seed in the soil of the prairies is certain, and at High Bluff, about 45 miles west of Winnipeg, I saw several thick clumps of flourishing young maples that had been thus raised and protected from fire.

The fact that, in most (if not all) of the more northerly prairie States, and in Manitoba, Tree Culture Acts are in force and have been perfectly successful in every case where sufficient inducements have been held out to encourage the planting of trees by settlers, and where sufficient time has been allowed, is proof positive that there is nothing in the soil of the prairies inimical to the growth of trees, if only they are planted and properly protected at first.

In the Province of Manitoba there is a Tree Culture Act, which was passed in 1883. Under the provisions of this Act, the Lieutenant-Governor annually, by proclamation, appoints a public holiday, known as "Arbor Day," for the sole purpose of tree-planting. "All municipal, religious, and school corporations are earnestly begged and recommended" to co-operate in this work, "which promises in the near future important results." In 1887, I happened to be in Winnipeg on "Arbor Day," which was the 10th of May. As a holiday, the day was well observed, but I did not see many trees planted.

Those who have occasion nowadays to cross those portions of Iowa and Southern Minnesota where, fifteen years ago, there existed nothing but a treeless and uninhabited prairie, will see numerous clusters of flourishing aspens, while every settler's house has a few trees planted around it for the sake of shelter from the high winds of the prairies. Again, along each side of the Northern Pacific Railroad, at least as far west as the Missouri, young aspens have been planted as snow-breaks wherever there is a danger of the line being blocked by drifting snow in winter. In years to come these will provide an inexpensive substitute for the wooden snow-breaks at present in use.

Clearly, therefore, it is demonstrated, beyond the slightest possibility of doubt, that trees can flourish in the soil of the prairies. In fact, one might almost as well discuss the point whether fishes can or cannot thrive in water! But, further than this, it is a matter of every-day observation on the prairies that on any piece of ground over which the fire is prevented from passing (as, for instance, that inside a settler's fire-guard), a flourishing growth of willows, roses, silver-leaf bushes, and poplars, at once shows itself. If a portion of the prairie escapes the fire for one year, the growth of bushes has time to attain a height of (say) one or two feet; but, by keeping the ground moist, they encourage the growth of long grass, and thus bring about more surely their own destruction, for, when the relentless fire comes, it catches the grass and burns the young shoots of the bushes along with it; but there is no reason whatever why the poplars, at least, should not grow into trees, if they were protected from the fire.

One man, who had round his house several clusters of well-grown young poplars, told me that he had observed them springing up ten years before, and had preserved them solely by means of a fire-guard. In confirmation of what is here advanced, I may mention the case of a very

intelligent Ontarian gentleman, now farming on the bare, treeless prairie, about five miles north of Brandon, Manitoba. On first taking up his land, he was assured by his neighbours that it was unreasonable to suppose he would ever get trees to grow on his farm, for had the soil been suitable to them, they would certainly have been there. But he was too acute to believe this, and observing in the spring of 1883 a number of young seedling poplars springing up in a slight depression where the soil was more moist than on the level ground, he protected them by a fire-guard. The result of this was, that when I saw them in the following September, they were a flourishing lot of young trees some two feet high, which he hoped soon to be able to transplant. These trees must have originated from wind-blown seeds, as there were, I believe, no other trees whatever within three or four miles at least; and the gentleman in question had to go eight or nine miles for his supply of winter firewood.

In support of this, I will again quote Prof. Hind, who says: * "In the State of Missouri, forests have sprung up with wonderful rapidity on the prairies, as the country became settled so as to resist and subdue the encroachment of the annual prairie fires from the west." Again he says †: "If willows and aspens were permitted to grow over the prairies, they would soon be converted into humid tracts, on which vegetable matter would accumulate, and a soil adapted to forest trees be formed. If a portion of the prairie escapes the fire for two or three years, the result is seen in the growth of willows and aspens, first in patches, then in large areas, which in a short time become united and cover the country, thus retarding evaporation and permitting the accumulation of vegetable matter in the soil. A fire comes, destroys the young forest-growth, and establishes a prairie once more. The reclamation of immense areas is not beyond human power; the extension of the prairies is evidently due to fires, and fires are caused by Indians."

My friend, Mr. Ernest E. Thompson, of Toronto, who is very familiar with the prairies of the Canadian North-west, says, in an article on Prairie Fires: ‡ "If a piece of prairie, almost anywhere, be protected for two consecutive years, it will be found covered with a growth of poplars and willows; therefore I conclude that, but for the fires, the whole country would be covered with bush."

Dr. C. A. White says, § "Without the least hesitation, the real cause of the present existence of the prairies in Iowa is the prevalence of annual fires. If these had been prevented fifty years ago, Iowa would now be a timbered instead of a prairie State."

In 'Scribner's Statistical Atlas of the United States' (1883, p. xxiii.),

* 'Red River and Assiniboine Exploring Expeditions,' vol. ii. p. 377.

† Ibid., vol. i. p. 357.

‡ 'Report of the Manitoban Department of Agriculture for 1883,' p. 491.

§ 'Geology of Iowa,' vol. i. p. 133; vide 'American Naturalist,' vol. xii. (1878) p. 93.

is the following passage:—"The prairie region is fast disappearing. The advent of civilised man upon the scene has had the effect of turning the scale in favour of arborescent vegetation. The cultivation of the soil of this level region increases its capacity for retaining moisture; forest and prairie fires have ceased; and, further, thousands upon thousands of acres of trees have been planted. The result is that the eastern part of what was, fifty years ago, a prairie region would scarcely be recognised as such to-day."

The facts, now clearly demonstrated, that not only can trees thrive in the soil of the prairies, but that they are incessantly striving to do so, and would succeed but for the fires, seem to me sufficient refutation of most of the views which have been brought forward by various writers to account for the treelessness of the prairies, as quoted in the commencement of this paper. In most of these, the fundamental contention is that there is something in the climate or in the physical or chemical constitution of the soil which prevents the growth of trees; but these views are, I feel certain, erroneous.

In connection with my statement that almost everywhere upon the prairies—even many miles from any other trees—a growth of young poplars and willows is always endeavouring to spring up, it is interesting to consider whence come the seeds of these young trees. It seems not improbable (though I cannot adduce evidence) that the level lands which are now prairie were once covered by a coniferous forest-growth, but the nature and very slow growth of coniferous trees would render their extermination very speedy under the constant recurrence of fires. As a result, we now find that by far the commonest trees are the poplars, chiefly the aspen (*Populus tremuloides*), the balsam poplar (*P. balsamifera*), and the cottonwood (*P. monilifera*), and various species of willow. These trees have great vitality in their roots, and repeatedly send up fresh shoots after the annual fires, until death from exhaustion ensues. Their downy seeds, too, are readily carried for long distances by means of the wind, and may lie dormant in the soil for years. That these seeds are thus distributed over long distances by the wind may be readily seen by any one who happens to be on the prairies during the few days in the spring when they happen to ripen. On this point I make the following verbatim extract from my note-book:—

"May 27th, 1887, Winnipeg, Manitoba.—No one who has been here during the last few days, which have been bright and fine, need wonder any longer how it is that, wherever the fire is prevented from running, young poplars at once spring up upon the prairie, even in places far removed from any other trees. During the last day or two, the air has been full of poplar-down, drifting slowly in the breeze, settling on one's clothes, tickling one's face, and catching in cobwebs wherever these are found. Probably the down comes from some considerable distance."

From all this it is clear that the prairies would quickly become covered with timber trees, were it not for the frequent fires.

Evidence as to the past and present destruction of forests, and consequent extension of the prairie through fire, is not less conclusive. An old Half-breed in Manitoba told an intimate friend of mine that when, as a boy, he used to hunt the buffalo on what is now known as the Big Plain, it was covered with bluffs of good timber, which have now almost entirely disappeared. Many settlers can point to some dead tree or small clump of bushes which forms the last remnant of a respectable-sized "bluff" that has been destroyed by the fire within the last year or two. A settler always likes, where possible, to be able to shelter his house from the icy blasts of winter behind some small bluff; but if he wishes to preserve his shelter, it is imperatively necessary to surround it with a fire-guard. There is hardly a bluff that does not show signs of the fierce conflict it annually has to wage with the merciless fire.

A typical case is something of this kind:—A fire comes over the prairie, and, arriving at the edge of a "bluff" (as isolated clumps of trees are always called in Manitoba), or at the edge of the more extensive "bush," it attacks the outer trees, burning one side of their trunks just above the ground, also leaping up and consuming their smaller branches. Thus, perhaps, over an area of several acres, the fire has eaten into the bush as far as there was any grass to carry it, consuming the underwood, injuring (if not killing) the trees, but still leaving them standing. Next year the fire comes again from the same direction. If any young underwood has sprung up, it is again destroyed, and the fire enlarges the hollow in the trunks of the standing trees that it commenced the year before. This, if it does not prostrate them, effectually destroys their vitality; while the fire proceeds on still farther into the bush, destroying as it goes. The year after, the hungry fire comes again—nearly always from the same direction. Again the undergrowth is destroyed; again the hollows in the tree-trunks just above the ground are enlarged; again some of the trees fall and lie charred and half-burned as the fire passes on, again adding a larger area to that over which it has already spread hideous disfigurement. Those trees which were first attacked, and which have not already fallen, have now great black hollows scooped out of their trunks, as if some animal had gnawed into their bases till nothing but a shell remained to support them. But the fire seldom forgets to return year by year. When it does come, it gnaws again at the same spot where it has already several times found food for its unappeasable appetite; the trees fall, and the fire, passing on in its haste to attack those it has as yet only partially overcome, leaves them as charred and blackened logs upon the ground. Year by year the fire comes; seizes on these logs; chars them more and more completely, and rushes on farther and farther into the bluff, as the

destruction of the trees on the margin allows the grass to grow further and further in; until, in a few years, it is all destroyed. Twenty or thirty acres of wood are often thus destroyed in, say, seven or eight years. Will any one imagine the trees will grow again in the same period? The bluff may have been growing there for centuries, or possibly it may have been destroyed in like manner many years before and have grown up again; but, as growth is slow, and destruction by fire is swift, it is evident that, although some of the destroyed bluffs do grow again, on the whole the prairies would be extended. And with such havoc as I have described going on year by year, who can wonder at it? I have sketched no fancy picture, but one which I have seen in all stages of completion in the bluffs round Carberry and elsewhere in Manitoba. It does not seem to me reasonable for any man who has seen the destructive effect of these fires to deny that sufficient time only is wanted for exactly the same means to have originated even the wide prairies themselves.

Over and over again Prof. Hind speaks of having observed the same thing—forests of large pines, spruces, or tamaracs, prostrated by the fire, to be partially succeeded by a less valuable growth of elm, poplar, or willow, which, in its turn, is at last destroyed. Here is what he says upon the subject: *—"That forests once covered a vast area in Rupert's Land [an old name for the Hudson's Bay Company's territories], there is no reason to doubt. Not only do the traditions of the natives refer to former forests, but the remains of many still exist as detached groves in secluded valleys, or on the crests of hills, or in the form of blackened, prostrated trunks, covered with rich grass, and sometimes with vegetable mould or drifted sand. The agent which has caused the destruction of the forest which once covered many parts of the prairies is undoubtedly fire; and the same swift and effectual destroyer prevents the young growth from acquiring dimensions, which would enable it to check their annual progress. Nearly everywhere, with the exception of the treeless, arid prairie west of the Souris, and west of Long Lake on the north side of the Qu'Appelle, young willows and aspens were showing themselves in 1858, where fire had not been in the previous year. South of the Assiniboine and Qu'Appelle, few plains had escaped the conflagration in 1857, and the blackened shoots of willow were visible as bushes, clumps, or wide-spreading thickets, where the fire had passed."

Again, he says: †—"The annual extension of the prairies from this cause [fire] is very remarkable. The limits of the wooded country are becoming less year by year; and, from the almost universal prevalence of small aspen woods, it appears that in former times the wooded country extended beyond the Qu'Appelle, for three or four degrees of latitude south of its present limit. . . . This lamentable destruction of forests is

* 'Exploring Expeditions,' vol. ii. p. 376.

† Loc. cit., vol. i. p. 405.

a great drawback to the country, and a serious obstacle to its future progress." The same facts must strike every observant traveller on the prairies.

Prof. Macoun, of the Geological Survey of Canada, has frequently expressed his firm belief in the opinions I have here advanced, and many statements in support of these views may be found in his interesting work, 'Manitoba and the Great North-West,' where he states (pp. 27, 28) that between the Rocky Mountains and an imaginary straight line connecting Moose Mountain and the Touchwood Hills, the whole country is utterly devoid of wood as far north as lat. 52°, with the exception of Wood Mountain, the Cypress Hills, and certain narrow river-valleys. He also says (p. 104): "The real cause of the absence of wood on every part of the region under consideration is undoubtedly prairie fires, which sweep over every part of it year after year, destroying the seedling trees as long as there are any seeds left to germinate, and year by year killing the bushes, till the capacity of the root to send up shoots dies out, and then even willows cease to grow."

Elsewhere, in reference to Prof. Hind's journey of exploration, Prof. Macoun significantly adds that "where he [in 1857] saw large forests, I passed over in 1880 and never saw a twig."

Dr. G. M. Dawson, of the Geological Survey of Canada, says of the prairies of the Peace river (which, however, are hardly true prairies) that "there can be no doubt that they have been produced and are maintained by fires. The country is naturally a wooded one, and, where fires have not run for a few years, young trees begin rapidly to spring up . . . and it is probable that, before the country was inhabited by Indians, it was everywhere densely forest-clad."

Mr. Frank M. Chapman has made an interesting observation upon the prairies around Corpus Christi, Texas, where the arborescent vegetation has largely appeared during the last twenty years, and is yearly becoming denser and more extensive. This he understands is due to the introduction of cattle, which by grazing down the grass have prevented the fire from "running" and thus destroying the tree-growth.*

Mr. Arthur Winslow, State Geologist of Missouri, makes a very similar observation on the prairies of Western Arkansas, which he regards as "due to a combination of causes: namely, the alternation from extremely cold wet soil during the rainy season to a hard dry soil in the dry season, and, further, the periodic recurrence of prairie fires." These prairies, however, have lost, or are fast losing, their treeless character, because, as they have now become "great open ranges for cattle, the grass is kept short, and there are no longer such fierce periodic conflagrations."† These observations show, in a remarkable degree, the baneful influence the fires must formerly have exercised,

* Bull. Am. Mus. Nat. Hist., vol. iii. (1891) p. 316.

† Bull. Geol. Soc. of Amer., vol. ii. (1891) p. 240.

for the grazing of cattle usually has the effect of preventing tree-growth.

The following extract from Dr. Asa Gray's paper on "The Characteristics of the North American Fauna," read before the Biological Section of the British Association at Montreal, on August 29th, 1884, is much to the point. He says:—"The prairies of the Atlantic States bordering the Mississippi and the Winnipeg country, shade off into the drier and gradually more saline plains, which, with an even and gradual rise, attain an elevation of 5000 or more where they abut against the Rocky Mountains. Until these are reached (over a space from the Alleghenies westward for about 20 degrees of longitude) the plains are unbroken. To a moderate distance beyond the Mississippi, the country must have been in the main naturally wooded. There is rainfall enough for forests on these actual prairies. Trees grow fairly well when planted; they are coming up spontaneously under present opportunities; and there is reason for thinking that all the prairies east of the Mississippi, and of the Missouri, up to Minnesota (and Manitoba) have either been greatly extended, or were even made treeless under Indian occupation and annual burnings. . . . The drier and barer plains beyond, clothed with the short buffalo grasses, probably never bore trees in their present state, except, as now, some cottonwoods (i. e. poplars) on the margins of the long rivers which traverse them in their course from the Rocky Mountains to the Mississippi. Westward the plains grow more and more saline; and wormwoods and *Chenopodiaceæ* of various sorts, form the dominant vegetation."

Prof. A. R. C. Selwyn, Director of the Geological Survey of Canada, writes:—"Whatever the effect may be of these destructive conflagrations, in reference to the water-supply of the region, there is no doubt that . . . hundreds of miles of forest have thus been converted into wide and almost treeless expanses of prairie." Dr. R. Bell, the Assistant-Director, in forwarding a report to Prof. Selwyn shortly after says:—"Your remarks upon the destruction of forests by fire between Red River and the Rocky Mountains are corroborated by all that I could hear upon the subject. The rapidity with which some tracts between Prairie Portage and Fort Ellice were stated to have been converted from forest to prairie, is almost incredible."

Could anything show more conclusively than the foregoing statements the destruction which these fires have wrought?

It may, however, be asked, What has become of the trunks and stumps of these destroyed trees? The former, lying upon the surface of the ground, would be annually attacked by the fire, and at last would be entirely converted into ash, or they would be speedily disintegrated, when once well rotted, by a species of ants which drives tunnels through such soft logs in all directions. Dr. Bell, in speaking of the district

south of Fort Ellice, writes:—"The aspens of that region burn much more readily than does the wood of the same tree in Ontario and Quebec, and the portions which escape total destruction by fire rot and disappear in the course of one or two years."

My friend, Mr. Ernest E. Thompson, of Toronto, writes:—"Far out on the open plains, sticks may be picked up and charred wood unearthed, showing where once were trees."

I have also heard of charred logs being dug up from below the surface of the open prairie. They had probably been covered by the burrowings of gophers and badgers. The working of these animals will also, to some extent, account for the disappearance of the roots and stumps of the trees; but it certainly is surprising that these should have disappeared so completely as they have done.

In discussing the destruction of the forests, we must take into consideration the fact that the fires, in nearly all cases, travel eastwards with the prevailing winds. In Manitoba, the mean resultant direction of the wind for eleven years (1871 to 1881 inclusive) was N. 44° W. This will help us to understand why trees, in the majority of cases, are upon the eastern side of a lake or river. Captain Butler remarks of the Red River:—"Its tributaries from the east flow through dense forests; those from the west, wind through the vast sandy wastes of the Dakota prairie, where trees are almost unknown."

Roughly speaking, the whole of the region for hundreds of miles to the east and north of Red River and Lakes Manitoba, Winnipegosis, Winnipeg, is one of dense forests, protected from the ravages of the prairie fires largely by those friendly pieces of water, while the whole region to the west is prairie, exposed to the fire.

Further, wherever there is an island in a lake, that island, being protected from the fire, is pretty certain to be covered with trees and bushes. Proofs of this may be seen everywhere on the prairies.†

* 'Report of the Manitoban Department of Agriculture for 1883,' p. 491.

† The following information as to the distribution of forest and prairie in the State of Minnesota is extracted from the Introduction to the State Directory for 1884-5, and I think bears out what has been advanced above. "One-third of the State is covered by forests, and about one-sixth more by groves and wood-fringes. . . . In the counties of Cook, Lake, St. Louis, Itaska, Beltrami, Cass, Aitkin, Carlton, Pine, Kannebec, Mille Lacs, Morrison, Crow-Wing, Isanti, Chisago, and in parts of counties lying adjacent to these, there are forests of white pine of probably one-fourth of the entire area." In the forest districts, there are some small prairies from which the forests have been burned. "All the country west of the Mississippi and north of the Minnesota river, extending west into the counties of Sibley, McLeod, Meeker, Kandiyohi, Pope, Grant, Douglas, Otter-Tail, Becker, and, to a lesser extent, into Norman, Polk, Marshall, and Kittson, and also that south of the Minnesota river, including the whole or parts of the counties of Scott, Rice, Steele, Waseca, Le Sueur, and Blue-Earth, properly belongs to the forest district. The counties of Houston, Fillmore, Winona, Olmstead, Dodge, Wabasha, Goodhue, Dakota, Hennepin, Ramsey, and Washington, though belonging to the prairie region, have a large area of timber which fringes the borders of the Mississippi and its larger tributaries, sometimes extending back as far as ten miles and forming dense

Another fact, familiar to every one that knows the prairies, which may, perhaps, be brought forward in controversion of the foregoing, is that nearly all the streams crossing the prairies are fringed with a narrow belt of trees *on both sides*, eastern and western or northern and southern alike. This is the case, even on absolutely treeless prairies, on which grass will scarcely grow, and is, I think, largely due to the fact that the wind is unable to drive the fire down the sloping sheltered banks of the stream, as it does on the level prairie.

But water is not the only obstacle to the progress of prairie fires. A range of sand-hills answers much the same purpose. These sand-hills, though composed of fine and almost absolutely-pure, wind-blown sand, are usually sparsely covered with stunted timber trees, thus affording a paradox that, while vast tracts of abnormally-fertile soil are treeless, smaller tracts of great sterility are fairly-well timbered. The explanation, as given by Prof. Macoun,* seems to be that, whereas the fertile prairies produce an abundance of grass, which "carries" the fire to burn the trees, the sand-hills, through their extreme poverty, do not grow sufficient grass to carry fire, and thus the few trees growing upon them are safe.

These, then, are the grounds on which I base my contentions—that fire is the agency which has destroyed the forest-growth which once covered the prairies, and that, were the fires stopped once for all, trees in plenty would soon grow up in all parts. Had these fires been stopped some fifty years ago, it is not, I believe, too much to say that the whole of the true prairie region would now have been more or less thickly covered with light forests of deciduous trees, while the province of Manitoba, instead of being known as the "Prairie Province," would better have merited the title of the "Sylvan Province."

I do not deny that there are subsidiary causes. For instance, were it not for the exceptional dryness of the North American climate, the grass would seldom be in a condition to burn over large areas; again, if the surface of the prairies was uneven and much broken, instead of fairly level, very few fires would travel for long distances; while, were it not for the high winds which are prevalent on the open prairies, the fires would find it equally difficult to travel far. All these causes have no doubt had their effect; but I contend that all of them conjointly would

forests. There is also considerable timber along the Minnesota and Red rivers and about the lakes. Kittson, Marshall, Polk, Norman, Clay, Wilkin, Traverse, Grant, Stevens, Pope, Bigstone, Swift, Chippewa, Kandiyohi, Redville, McLeod, Sibley, and Nicollet, on the north side of the Minnesota river; Lac-qui-Parle, Yellow Medicine, Lincoln, Lyon, Redwood, Browne, Pipestone, Murray, Cottonwood, Watoñwan, Rock, Nobles, Jackson, Martin, Freeborn, Faribault, Mower, Dakota, Goodhue, Wabasha, Olmstead, and Dodge, south of that river; and Ramsey and Washington, on the east side of the Mississippi, are properly prairie counties. All the others contain woodland enough to entitle them to rank as timbered regions."

* "Manitoba and the Great North-west," p. 105.

never have produced a prairie over an area which is naturally timbered were it not for the action of the fires.

If it be held that my view is untenable because in other continents, where fires have not prevailed, large areas of fertile soil also remain treeless, I answer that, although this may be the case, it does not by any means necessarily follow. The chief open grass-covered fertile regions of the world all occupy the central portions of large continents. They are as follows:—In North America, the prairies and the plains; in South America the pampas, the llanos, and the great grass-covered areas in the valley of the Amazon; in Asia, the steppes of Southern Siberia; and in Europe, the steppes of Southern Russia, which are to some extent a continuation of those of Asia. All these may or may not have had a different origin from the prairies, just as I believe the American plains are treeless from a cause different from that accounting for the openness of the prairies.

In this connection, I should allude to the *tschornozem*, or black earth, of Southern Russia, described by Sir Roderick Murchison in his 'Geology of Russia in Europe and the Ural Mountains' (vol. i. p. 557), and in the 'Journal of the Royal Agricultural Society' (vol. iii. p. 125). The black earth occupies an enormous region, extending from Hungary on the west, completely across southern Russia, and covering a very large area on the Siberian plains. It overlies all other kinds of soil, occurs at all elevations, and varies from 15 feet to 20 feet in thickness. It is "jet black when moist," is similar in nature throughout the entire area, and is so light and fine that travellers crossing it in a dry season are often thickly covered with a black dust, which rises up in clouds through the grass when disturbed by a horse's feet. The soil of the black earth region, like that of the prairies, is so excessively fertile that slovenly methods of farming are encouraged, and manure is allowed to accumulate in "hillocks of considerable magnitude." The foregoing description and the following analysis of it would serve almost equally well for the black soil either of Russia or Manitoba:—

Silica	69.8
Alumina	13.5
Lime	1.6
Oxide of iron	7.0
Organic matter	6.4
Traces of humic acid, chlorine, &c.	1.7
	<hr/>
	100.0

Sir Roderick Murchison is altogether opposed to the belief that the Russian black earth is "the humus arising from decayed forests or vegetables during the present period," though he admits this to be "the prevalent opinion in Russia." He regards it as a sub-aqueous deposit, probably derived from the denudation of the black Jurassic shale; but he does not deny that some speculation is needed in order to

account for the whole area covered on this hypothesis. He does not allude to the possible action of fire, but is "firmly persuaded that by no efforts could any Government produce forests in those districts except in certain rocky and moist spots." This may be quite true of the Russian steppes; but I am confident that the case is different with the prairies of America.

If the reasons I have adduced to account for the treelessness of the prairies cannot be safely applied to the whole of the prairie region in North America, then I urge that at least they apply fully to the northern portion of that area, with which I am most familiar.

Exploration in the Central Caucasus in 1890.

By DOUGLAS W. FRESHFIELD, HON. SEC. R.G.S.

Map and Panorama, p. 140.

THE exploration and survey of the Central Caucasus progress steadily from year to year. The advance made in the last five years has been prodigious, and the time is now approaching—if it has not already arrived—when it will become expedient to arrange and summarise our knowledge. An essential preliminary to any such summary must be the formal division of the range for descriptive purposes into groups. In a chain, the glaciers of which are not broken for a space of 80 miles, which has no grass-pass between the Mamisson and the latitude of Sukhum Kaleh across its main ridge, such divisions must in places be more or less arbitrary. I shall, however, venture to suggest here those that seem to me most suitable, in the hope that they may meet with general acceptance. They are as follows:—

1. *Kasbek Group*. The range enclosed between the sources of the Terek and Ardon, not part of the watershed.
2. The main ridge from the Krestowaya Gora (Cross Pass) to the Mamisson Pass, which might be named the *Ardon Group*. Unlike the more western part of the main chain it is crossed by numerous horse-passes—a physical fact which accounts for Transcaucasian Ossetia.
3. The *Adai Khokh Group*, extending from the Mamisson to the Gebi-vsek, a glacier pass leading north from Gebi to Stir-Digoria on the Urukh.
4. The *Fastak Khokh* or *Rion Passes Group*, extending from the Gebi-vsek westwards to the Ciri-vsek, which leads from Balkar on the north to the Zenès-Skali sources.
5. The *Giuliukh Group*, an unexplored cluster of granite peaks lying north of the watershed, between the Cherek and the Urukh.*
6. The *Central Group* from the Ciri-vsek to the Zanner Pass, including all the peaks between Balkar and Bezingi.
7. The *Tiklingen Group*, extending from the Zanner Pass to the pass at the western head of the Leksur or Gvalda Glacier, and including the great Suanetian glaciers.
8. The *Chegem Group*, north of the watershed between the Adyrso, Baksan, and the Cheghem torrent.

* A horse-track leads from Stir-Digoria to Balkar, over the northern spurs of this range. It deserves the next traveller's notice.